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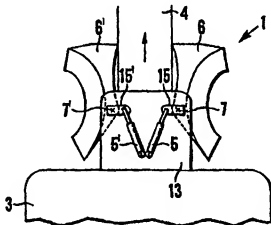
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(21) International Application Number: PCT/NO97/00210 (22) International Filing Date: 19 August 1997 (19.08.97) (30) Priority Date: 19 August 1996 (19.08.96) NO 963453 (71) Applicant (for all designated States except US): KVÆRNER ASA [NO:NO]; P.O. Box 169, N-1324 Lysaker (NO). (72) Inventors; and (75) Inventors/Applicants (for US only): PAULSEN, Kim [NO:NO]; Bispeveien 37, N-1347 Hovle (NO); RUFFO, Pierre [NO:NO]; Noreveien 15c, N-0379 Oslo (NO). (74) Agent: ONSAGERS PATENTKONTOR - DEFENSOR AS; P.O. Box 265 Sentrum, N-0103 Oslo (NO).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published With international search report. In English translation (filed in Norwegian).

(54) Title: WATER JET STEERING APPARATUS

(57) Abstract

A steering apparatus (1) for a water jet in a vessel (3), for lateral and reversible steering of a water jet (4) which is backwardly directed in relation to the vessel (3), comprises two flow profiles (6, 6') each of which is rotatable about its vertical axis of rotation (7, 7') and individually steerable by its line actuator (5, 5'), provided on each side of the water jet (4). Each of the flow profiles (6, 6') can be rotated between a forward position, where the water jet is not steered, a turning position, where a substantially vertical turning surface (8, 8') is rotated into the water jet (4) and deflects it laterally, and a reverse position where vertical reverse surfaces (9, 9') are rotated into the water jet (4), diverting a part of the water jet (4) for deflection downwards and forwards.



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Water jet steering apparatus

The invention concerns a steering apparatus for a water jet in a vessel, for lateral and reversible steering of a water jet which is backwardly directed in relation to the vessel and generated by the water jet, comprising two steering
5 and reversing elements, each rotatable about its vertical axis of rotation and individually steerable by its linear actuator, provided on each side of the water jet, wherein each of the steering and reversing elements can be rotated between a forward position, where the water jet is not steered, a turning position, a reverse position where the water jet is deflected downwards and
10 forwards, and intermediate positions.

Water jets are used to a certain extent in the propulsion of ships. A water jet comprises a water inlet which passes water from the ship's underside to a pump which is located in a pump housing and driven by a motor. A water
15 outlet directed backwards from the pump housing produces a backwardly directed water jet which propels the ship forwards. A steering and reversing apparatus alters the direction of the water jet and thereby steers the vessel. When reversing the vessel the water jet is steered forwards, and it also must be steered downwards, since otherwise it would strike the vessel.

In these known water jets the steering apparatus may be designed in various
20 ways, which work satisfactorily per se. A common feature of these steering apparatuses, however, is that they are complicated, have a large number of movable parts and several hydraulic cylinders in order to steer the parts. They are therefore expensive to manufacture and maintain, in addition to which they are heavy, which is undesirable since it increases the size of
25 motor required and the fuel consumption.

SE 467 304 describes a steering apparatus for a water jet which comprises two steering and reversing elements mounted on each side of an outlet pipe for the water jet. The steering and reversing elements are each rotatable about its vertical axis of rotation, and can each be steered individually by its
30 hydraulic cylinder. The steering and reversing elements consist of a front part, located in front of the axis of rotation, which can be rotated into the water jet, diverting a part thereof and leading this part to the side, thus producing a steering effect. The steering and reversing elements also comprise a rear part which is bucket-shaped and slantingly downwardly

directed, constructed in one piece with the forward part. The rear part is located behind the axis of rotation, and can be rotated into the water jet, leading it slantingly downwards, thus producing a reversing effect without the water jet striking the stern.

- 5 Compared with other steering apparatuses for water jets the steering apparatus according to SE 467 304 is simpler, and consequently advantageous both with regard to production and maintenance. However, it has the drawback that the steering and reversing elements are made of relatively thin plates, thus exposing them to the possibility of damage in the event of a collision.

10 An object of the invention is to provide a steering apparatus for a water jet, which steering apparatus should consist of few parts and be so robust that it is not easily damaged in the event of a collision.

- 15 A further object of the invention is to provide a steering apparatus with a lower weight than the known steering apparatuses.

The objects are achieved according to the invention with a steering apparatus of the type mentioned in the introduction, characterized by the features which are specified in the claims.

- 20 In this patent application the terms "forward", "backward" and "reverse" should be understood in relation to a vessel's normal direction of movement.

The invention will now be explained in more detail in association with a description of a specific embodiment and with reference to the drawing, in which:

- 25 fig. 1 shows a steering apparatus for a water jet according to the invention, viewed from above, in a forward position,
fig. 2 shows the steering apparatus viewed from behind,
fig. 3 shows the steering apparatus viewed from the side,
fig. 4 shows the steering apparatus viewed from above, in a turning position,
30 fig. 5 shows the steering apparatus viewed from above, in a reversing position,

fig. 6 shows the steering apparatus viewed from above, in a non-propulsion position, and

fig. 7 shows the steering apparatus viewed from above, in a turning/reversing position.

- 5 The same reference numerals are used for corresponding parts in all the figures.

Fig. 1 illustrates a stern section of a vessel 3, viewed from above, with a steering apparatus 1 according to the invention. A backwardly directed water jet 4 flows out from the vessel and drives the vessel forward. The water jet 4 is produced by a water jet in the form of an impeller in a pump housing, which is supplied with water from a water inlet and is driven by a motor. A guide apparatus is located between the pump housing and the water outlet to convert the flow of water from the impeller into the most optimal water jet for propelling the vessel forward. The guide apparatus, the pump housing with the impeller, the water inlet and the motor are located inside the vessel, and not shown in the drawing. These components which produce the water jet are designed according to the prior art, and will not be described in more detail.

- 20 The steering apparatus is symmetrical about the water jet 4. Like parts on the right and left sides of the steering apparatus are indicated by like reference numerals, with the addition of a mark (5', etc.) for the reference numerals for the parts on the left side.

- 25 The steering apparatus 1 comprises two flow profiles 6, 6' provided on each side of the water jet 4. The flow profiles 6, 6' are each rotatable about its vertical axis of rotation 7, 7', and are each individually steered by its linear actuator which is here shown as hydraulic cylinders 5, 5'. The movement of the hydraulic cylinders is transferred to the flow profiles via link arms 15, 15'.

- 30 Figs. 2 and 3 show the steering apparatus from the back and from the side respectively, and illustrate how a horizontal upper support plate 13 and a horizontal lower support plate 14 support the flow profiles 6, 6' and the hydraulic cylinders 5, 5' and form a mounting for their movement.

The flow profiles consist of three substantially vertical surfaces, see fig. 4, a turning surface 8, 8', a reverse surface 9, 9' and a neutral surface 10, 10'. The turning surface 8, 8' and the reverse surface 9, 9' are concave, while the neutral surface 10, 10' is flat. In addition, the reverse surface is provided with
5 downwardly directed ribs or blades 12, 12'. The neutral surface 10, 10' forms an obtuse angle with the turning surface 8, 8', and an acute angle with the reverse surface 9, 9', thus producing an edge 11, 11'.

The turning surface, the reverse surface and the neutral surface are arranged in relation to the flow profile's axis of rotation in such a manner that during
10 steering the turning surface will influence the water jet in an area behind the axis of rotation 7, 7', while the reverse surface and the neutral surface will influence the water jet in an area in front of the axis of rotation.

The arrows in fig. 1 and 4-7 indicate the water jet's direction of movement.

Fig. 1 shows the steering apparatus in a forward position, where both flow
15 profiles are in a forward position. The flow profiles do not touch the water jet, and the vessel moves straight ahead.

Figs. 4-7 illustrate how the steering function is produced, showing only the flow profiles and the water jet.

Fig. 4 shows the steering apparatus in a turning position. The right flow
20 profile 6 is located here in a turning position, where the turning surface 8 is pressed into the water jet 4, thus causing the jet to be deflected in a direction opposite to the flow profile 6, i.e. to the left of the figure. The left flow profile 6' is in a neutral position, where the turning surface 8' is rotated to the left in order to make room for the deflected water jet 4, and where the neutral
25 surface 10' is rotated into the jet, in a position parallel thereto, thus causing the water jet to move freely along the free surface.

Fig. 5 shows the steering apparatus in a reverse position, where both the reverse surfaces 9, 9' are inside the water jet 4 with the edges 11, 11' in the middle of the water jet. Each of the edges 11, 11' diverts its half of the water
30 jet and guides this half jet along the reverse surface 9, 9' with the ribs 12, 12', with the result that the two water jet halves are directed downwards and forwards.

- Fig. 6 shows the steering apparatus in a non-propulsion position, where the water jet is steered to flow both forward and backward and the vessel is at rest. Here the flow profiles are in a position between neutral position and reverse position, where both the reverse surfaces 9, 9' are located slightly inside the water jet 4. Each of the edges 11, 11' diverts an outer part of the water jet and guides this jet part along the reverse surface 9, 9' with the ribs 12, 12', with the result that the two jet parts are directed downwards and forwards. The central part of the water jet is not influenced by the flow profiles, and is thus able to flow freely backwards.
- Fig. 7 shows the steering apparatus in a combined turning and reverse position, where the flow profiles 6, 6' are rotated by different amounts from their neutral position towards their reverse position. The edges 11, 11' divert different amounts of the water jet 4, resulting in different magnitudes of downwardly directed and backwardly directed flows on each side of the vessel.

A number of other combined positions and intermediate positions are possible. There will be no direct, proportional correlation between the possible positions of the flow profiles and the steering functions. Thus steering of the vessel with the steering apparatus according to the invention should preferably be conducted by means of a computer, which on the basis of a selected steering command, by means of a specially developed algorithm, calculates the position of the flow profiles.

The optimal position of the flow profiles in relation to the water jet will depend on the rotational position of the flow profiles, and may also depend on the water jet's output. The axes of rotation of the flow profiles may therefore be horizontally movable. Devices for execution of this horizontal movability are not shown in the drawing, but may, for example, be implemented with rotating joints and linear actuators, sliding connections and linear actuators, or rotation of cam profiles.

- Compared with the steering apparatus described in SE 467 304 mentioned at the beginning, with the invention a more robust steering apparatus is obtained, which is not easily damaged in the event of a collision. A steering apparatus is further obtained which has shorter projections aft and a lower weight than the known steering apparatuses.

In the above the invention has been explained with reference to a specific embodiment. However, it is clear that a number of variants, particularly connected to the design of the flow profiles, will be able to be implemented by a person skilled in the art within the framework of the claims. The turning
5 surfaces, reverse surfaces and neutral surfaces are indicated as substantially vertical, this form being chosen because it is favourable from the production point of view, since the flow profiles can be manufactured by welding. It is obvious that from the flow point of view a number of other forms are possible, for example forms where the flow profiles partly envelop the water
10 jet, and that these forms may be relevant if the flow profiles are manufactured by moulding.

Other possibilities for variation are associated with the mounting of the flow profiles and the hydraulic cylinders, with, for example, the illustrated upper
15 and lower support plates being replaced by beam structures, or the mountings may be integrated in the vessel.

PATENT CLAIMS

1. A steering apparatus (1) for a water jet in a vessel (3), for lateral and reversible steering of a water jet (4) which is backwardly directed in relation to the vessel (3) and generated by the water jet, comprising two steering and reversing elements, each rotatable about its vertical axis of rotation (7, 7') and individually steerable by its linear actuator (5, 5'), provided on each side of the water jet (4), wherein each of the steering and reversing elements can be rotated between a forward position, where the water jet is not steered, a turning position, a reverse position where the water jet is deflected downwards and forwards, and intermediate positions, characterized in that each of the steering and reversing elements consists of a flow profile (6, 6') with a substantially vertical turning surface (8, 8') which during the turning position, in an area behind the flow profile's axis of rotation (7, 7') is rotated from the forward position into the water jet (4) for deflection of the jet (4) in a direction opposite the flow profile (6, 6'), and a substantially vertical reverse surface (9, 9') which during the reverse position, in an area in front of the flow profile's axis of rotation (7, 7') is rotated from the forward position into the water jet (4), diverting a part of the water jet (4) for deflection downwards and forwards.
2. A steering apparatus (1) according to claim 1, characterized in that each of the flow profiles (6, 6') also has a substantially vertical neutral surface (10, 10') provided at an obtuse angle in relation to the turning surface (8, 8'), with the result that the neutral surface (10, 10') in a neutral position for the flow profile, where the flow profile's turning surface (8, 8') is rotated from the forward position away from the water jet (4), permitting the water jet to be deflected towards the flow profile's side, extends parallel to the water jet.
3. A steering apparatus (1) according to claim 2, characterized in that the neutral surface (10, 10') is provided at an acute angle in relation to the reverse surface (9, 9'), with the result that the neutral surface and the reverse surface form an edge (11, 11'), which in the flow profile's reverse position provides the said diverting of the water jet (4).

4. A steering apparatus (1) according to one of the preceding claims, characterized in that the turning surface (8, 8') is concave.
5. A steering apparatus (1) according to one of the preceding claims, characterized in that the reverse surface (9, 9') is concave.
- 5 6. A steering apparatus (1) according to one of the preceding claims, characterized in that the reverse surface (9, 9') is provided with downwardly directed ribs or blades (12, 12') for downwardly directed deflection of the water jet (4).
7. A steering apparatus (1) according to one of the preceding claims,
10 characterized in that a turning position for the vessel is established when one flow profile (6) is in a turning position and the other flow profile (6') is in a neutral position.
8. A steering apparatus (1) according to one of the preceding claims,
15 characterized in that a non-propulsion position for the vessel (3), where the water jet (4) is steered to flow both forwards and backwards and the vessel is at rest, is established when the flow profiles (6, 6') are in a position between neutral position and reverse position.
9. A steering apparatus (1) according to one of the preceding claims,
20 characterized in that a combined turning and reverse position for the vessel (3) is established when the flow profiles (6, 6') are rotated by unequal amounts from their forward position towards the reverse position.
10. A steering apparatus (1) according to one of the preceding claims,
25 characterized in that the flow profiles' axes of rotation (7, 7') are horizontally movable to attain an optimal position of the flow profiles (6, 6') in relation to the water jet (4).

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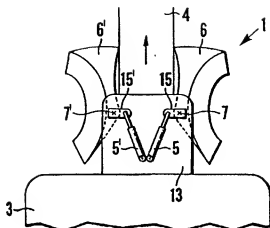


Fig. 1

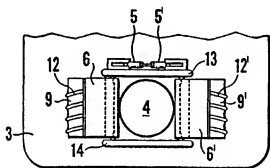


Fig. 2

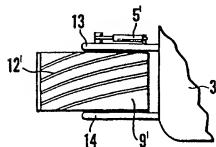


Fig. 3

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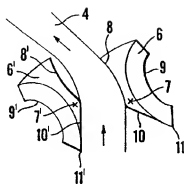


Fig. 4

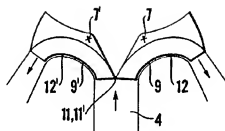


Fig. 5

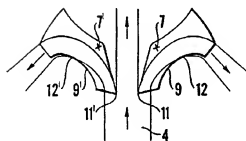


Fig. 6

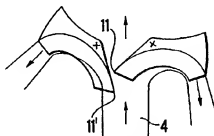


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 97/00210

A. CLASSIFICATION OF SUBJECT MATTER		
IPC6: B63H 11/107 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC6: B63H		
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